TRYGON ELECTRONICS, INC.

INSTRUCTION AND MAINTENANCE MANUAL

MODEL NO. TM36-10A ~~QTB3~~

SERIAL NO. 7 3657 H

TRYGON ELECTRONICS, INC.
INSTRUCTION AND MAINTENANCE MANUAL

MODEL NO. TM36-10A ~~C783~~

SERIAL NO. 7 3657 H

This unit is identical to the standard

Trygon Model M36-10A

except for special paint.

TRANSISTORIZED POWER SUPPLIES

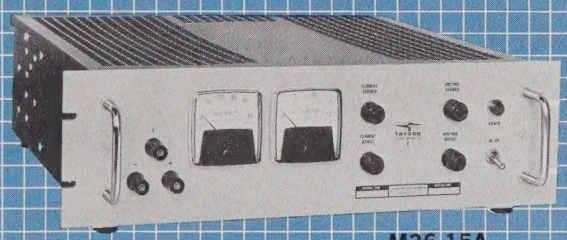
MERCURY INSTRUMENT SERIES

OUTPUT VDC: 0-15, 0-36, 0-60, 0-160

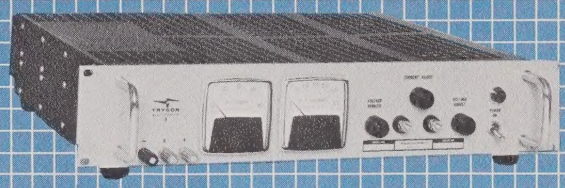
REGULATION: 0.01% or 3 mv
0.05% or 15 mv, Line or Load

RIPPLE: Less than 1 mv, RMS

INPUT: 105-125 VAC, 55-65 cps
200-240 VAC, 50 or 400 cps available



M36-15A



M60-2.5C

ELECTRICAL SPECIFICATIONS

REGULATED VOLTAGE MODE

Output: See above; floating output.

Regulation, Load: 0.01% or 3 mv* (Models with "A" suffix); 0.05% or 15 mv* (3½" models); no-load to full-load at any output within specifications.

Regulation, Line: 0.01% or 3 mv* (Models with "A" suffix); 0.05% or 15 mv* (3½" models); for 105-125 VAC line change at any output within specifications.

Ripple: Less than 1 mv RMS.

Stability:** 0.05% or 18 mv*, for 8 hours after initial warm-up.

Ambient Operating Temperature: −20°C to +50°C.

Temperature Coefficient: 0.05%/°C.

Recovery Time: 50 μsec to recover to within 15 mv of output voltage for 100% step change in rated load.

Short Circuit Protection: Adjustable Current Limiting (ACL); continuously adjustable from 50 ma to rated output current. Fully automatic reset.

Remote Programming: All units remotely programmable over full voltage range without derating. Scale factor: 100 ohms/volt for "A" suffix units; 50 ohms/volt for 3½" models except M160-1: 100 ohms/volt.

Remote Sensing: Provided on all models. Maintains rated regulation directly at the load.

Voltage Adjustment Range: Continuously adjustable over complete range. Front panel voltage adjust and voltage vernier controls.

*Whichever is greater
**Stability of 0.01% or 2 mv with a T.C. of 0.01%/°C +100μv is available as an option on all units with suffix "A".

Model	OUTPUT Volts	Amps	*Impedance DC-1KC	DIMENSIONS W	H	D	Weight (lbs.)
M15-10	0-15	0-10	0.004	19"	3½"	15"	40
M36-2.5	0-36	0-2.5	0.008	19"	3½"	15"	40
M36-5	0-36	0-5	0.004	19"	3½"	15"	40
M60-2.5	0-60	0-2.5	0.012	19"	3½"	15"	40
M160-1	0-160	0-1	0.08	19"	3½"	15"	40
M15-15A	0-15	0-15	0.002	19"	5¼"	14½"	55
M15-30A	0-15	0-30	0.001	19"	5¼"	14½"	65
M15-50A	0-15	0-50	0.001	19"	7"	16"	75
M36-10A	0-36	0-10	0.002	19"	5¼"	14½"	55
M36-15A	0-36	0-15	0.002	19"	5¼"	14½"	58
M36-25A	0-36	0-25	0.001	19"	7"	16"	90
M36-30A	0-36	0-30	0.001	19"	7"	16"	105
M60-5A	0-60	0-5	0.006	19"	5¼"	14½"	55
M60-10A	0-60	0-10	0.004	19"	5¼"	14½"	58
M60-15A	0-60	0-15	0.002	19"	7"	16"	90
M160-3A	0-160	0-3	0.05	19"	5¼"	14½"	58
M160-5A	0-160	0-5	0.03	19"	7"	16"	82

*Nominal; DC-1 KC.

CONSTANT CURRENT MODE

NOTE: For models with suffix "A", constant current mode with automatic crossover is standard; for 3½" models constant current mode is optional at extra cost and is mode switched by rear panel mode selector switch.

	3½" Models	"A" Suffix Models
Output:	50 ma to rated current output.	50 ma to rated current output.
Voltage Compliance:	Zero to rated voltage output.	Zero to rated voltage output.
Regulation (Line or Load):	0.05% or 400μA* no-load to full-load at any rated current.	0.5% or 10 ma*
Ripple:	0.01% or 40 μA*	0.5% or 10 ma*
Stability:**	0.5% or 10 ma*	0.5% or 10 ma*
Temperature Coefficient:	0.1%/°C +5 ma	0.1%/°C +5 ma
Remote Programming:	n/a	50 ma to rated output***

*Whichever is greater.
**for 8 hours after initial warm-up
***Remotely programmable over full current range from 50 ma to rated output. Programming resistance R_{pgm} = 100 (1- I load/I rated).

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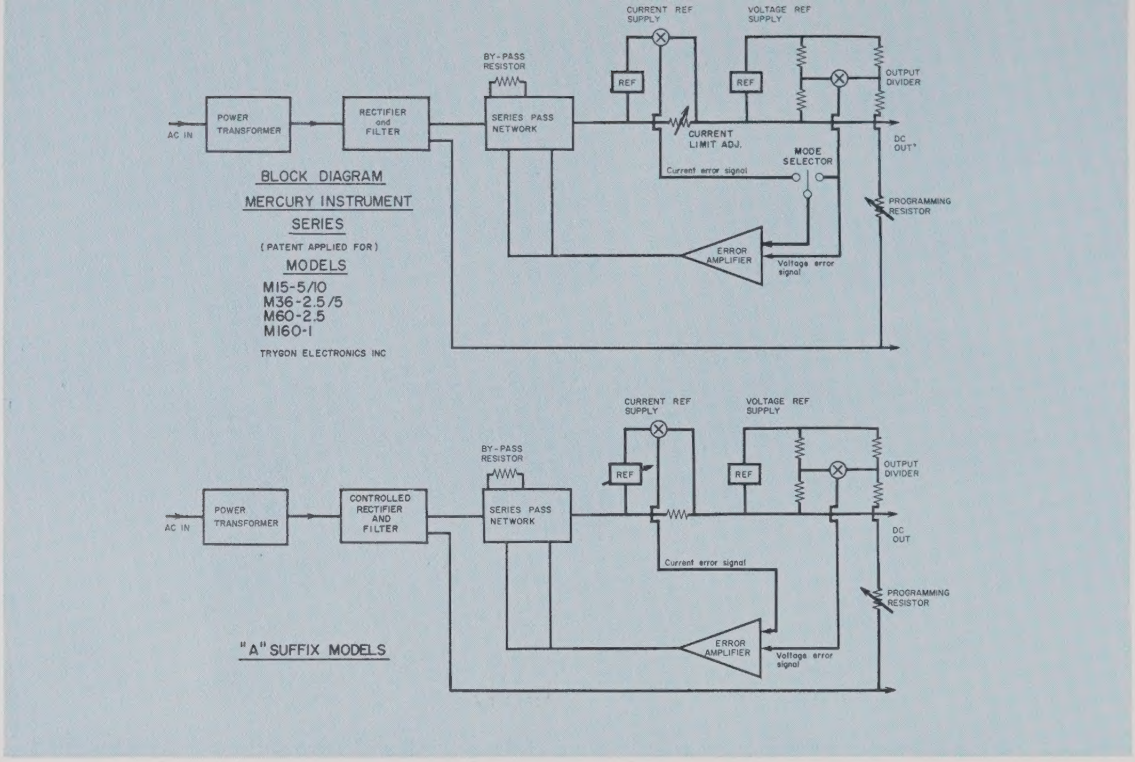


Mercury Instrument Series; Functional Diagram

GENERAL AND PHYSICAL SPECIFICATIONS

Modes: Constant Voltage/Constant Current standard on A Models, optional on 3½" Models.

Input: 105-125 VAC, 55-65 cps, standard; 50 and 400 cps optional.

Controls Front Panel: Voltage Adjust — Voltage Vernier — Current Adjust — Power (AC ON) — Power Indicator Lamp — Current Vernier: "A" Models only.

Metering: Front Panel Voltmeter and Ammeter; 2% accuracy.

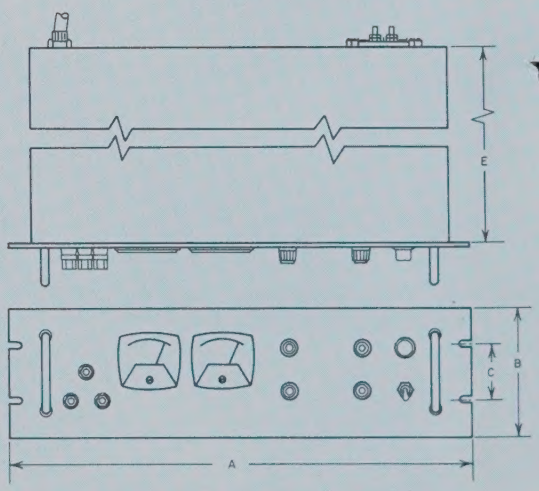
Terminals:
Front Panel: Positive, Negative, Ground; convenience terminals.
Rear Panel: Positive, Negative, Ground, Rem. Sensing Pos., Rem. Sensing Neg., Rem. Programming.

● TRYGON MERCURY INSTRUMENT SERIES comprises more than 18 standard models in two basic groups distinguished by an "A" suffix in the model designation. Those models without "A suffixes are compact (3½" rack height) units operating in the precision regulated voltage mode. On these units constant current mode operation is available as an optional extra; such units carry a "C" suffix. MERCURY INSTRUMENT SERIES supplies carrying an "A" suffix are capable of operation in either the constant voltage or constant current mode. These have automatic crossover from one mode to the other whereas 3½" models include a rear panel mode switch for mode selection.

● Quality and reliability of MERCURY INSTRUMENT supplies are extraordinary.

● Only top quality components are used: all electrolytic **filter capacitors** are **computer grade** with manufacturer's rated life in excess of 10 years; **power transistors** are generously **derated** and **temperature aged; rectifiers** are **hermetically-sealed silicon** types; all **zener diodes** are **temperature stabilized; transformers** meet or exceed **MIL-T-27A.** All components are subjected to 100% incoming inspection. Every unit is tested to meet every specification given. All supplies are manufactured to the procedures of MIL-Q-9858. Every Trygon supply carries a 5-year Warranty.

● *AUTOMATIC OVERVOLTAGE PROTECTION: Trygon has pioneered an **automatic** fail/safe Overvoltage Protection (OV) circuit which — under any conditions — will protect the load against receiving a voltage in excess of the programmed output voltage of the supply. Trygon OV is fully automatic, unlike conventional manually-operated types; the protection point automatically tracks the programmed output voltage.



	A	B	C	E
5¼" M Models	19"	5 7/32"	2¼"	14½"
7" M Models	19"	6 31/32"	4"	16"
3½" M Models	19"	3 15/32"	3"	15"

*Optional

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M264

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MEASUREMENT OF REGULATION AND RIPPLE

The specifications cited herein for Regulation and Ripple can be readily attained on every Trygon Power Supply, provided the proper method of measurement is employed.

Refer to Trygon Drawing B-1567 enclosed for the detailed test set-up.

The major consideration is that the highly stable meter and oscilloscope must be connected to the sensing terminals and not at the load terminals. The reason for this precaution is that the voltage drop between the load terminals and sensing terminals will yield an inaccurate Regulation and Ripple Measurement.

GENERAL DESCRIPTION

1) INTRODUCTION

The Mercury series of transistorized power supplies are precision regulated supplies for laboratory and systems applications. Their extraordinary flexibility makes them an ideal basic laboratory supply, while their wide power range allows their applications in text systems.

The Mercury Instrument supply provides for a versatile laboratory or test equipment unit. Included are coarse and fine voltage adjust, full range remote programming, remote sensing, voltmeter and ammeter and adjustable short circuit current protection (current limiting). On all units with suffix "A", constant current operation is also provided by means of an automatic crossover network from constant voltage to the constant current mode. On all other models, constant current operation is provided as an optional feature by means of a toggle switch on the rear panel.

Automatic overvoltage protection is available as an optional feature on all units. The Mercury power supply utilizes the highest grade of electronic components. All electrolytic filter capacitors are computer quality components, on which the manufacturer quotes an expected operating life in excess of ten (10) years. All power transistors are carefully derated and temperature aged to optimize reliable operation. All rectifiers are hermetically sealed silicon units, while all Zeners are temperature stabilized.

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2) PHYSICAL CHARACTERISTICS

All Mercury units are designed for rack mounting. Both the power output and the remote sensing leads are located on the rear panel. Located on the front panel are convenience output terminals, coarse and fine voltage adjust, current adjust, power switch and pilot light. No load fuse is required since the short circuit protection is fully automatic. The back of the supply also houses a line fuse and the remote programming terminals as well as an AC line cord.

OPERATING INSTRUCTIONS

1) TURNING ON THE INSTRUMENT

Plug power cord into 115 volt, 60 cps line outlet and turn on power switch. No warm-up time is required in order to operate the unit. However, to achieve rated stability specifications, a 60 minute warm-up period is recommended.

2) LOAD CONNECTION

Connect the load to the rear output terminals marked (+) and (-). Remote sensing terminals are provided on the rear in order to maintain rated regulation at the load. If remote sensing is not utilized be sure that the jumpers are connected between positive output and positive sensing and negative output and negative sensing in the rear of the unit. NOTE: FRONT TERMINALS ARE CONVENIENCE OUTPUTS ONLY AND WILL NOT PROVIDE RATED REGULATION.

3) REMOTE SENSING

The regulation of the supply is maintained at the end of

REMOTE SENSING (Cont'd)

the remote sensing connections. When the sensing leads are strapped to the output terminals, the regulation is maintained at the output terminals. When it is desired to maintain the regulation at the load rather than at the supply terminals (i.e. to bypass the effect of voltage drops in the wires running to the load), break the connection of the sensing leads at the back panel barrier strip by removing the two small metal jumpers and run separate remote sensing leads to the load. Be sure to connect the positive sensing lead to the positive side of the load and the negative sensing lead to the negative side of the load. If the sensing leads are to make a long run past relatively high magnetic fields, the use of twisted shielded pair is recommended with the shield connected to the ground terminal of the supply.

4) GROUNDING

Either side of the output may be grounded or the output may be used in a floating condition. The output is electrically isolated from the chassis.

5) REMOTE PROGRAMMING

All Mercury Instrument (M) supplies are programmable over the entire voltage range. In order to program the supply from a remote position, remove the rear terminal jumper between terminals 3 and 4 and transfer jumper to terminals 4 and 5. Connect the programming resistor between terminals 3 and 4. Since the output voltage is now

a function of the programming resistance, a low temperature coefficient resistor with at least a 3 watt rating is recommended. The "A" series supplies program at 100 ohms per volt and the 3 1/2" unit program at 50 ohms per volt; except the M160-1 which is 100 ohms per volt.

REMOTE CURRENT PROGRAMMING "A" SERIES-SEE PAGE 9

6) SHORT CIRCUIT PROTECTION

All Instrument models have adjustable current limiting short circuit protection. The following procedure is to be used when adjusting the current limit. Short the output of the supply and vary the current limit controls until the ammeter reads the desired current. This adjustment may be made anywhere from 50 ma to the rated output of the supply. Remove the short and connect the load to the supply. Under no conditions will the output current exceed the pre-set value. In case of a short circuit the voltage will drop to zero. When the short is removed the supply will automatically return to its normal operating voltage.

7) CONSTANT CURRENT OPERATION

Two types of current regulation are provided in the Mercury Instrument supplies. In the units without suffix "A" (3½" panel height) the constant current mode is an optional feature and is designated by a "C" in the model number. (For instance M36-5C). In this case the rear panel houses a mode selector toggle switch which changes the unit either into a constant voltage or constant current supply as desired. Since this switch also switches the output capacitor, the constant current mode maintains high output impedance for

CONSTANT CURRENT OPERATION (Cont'd)

high as well as low frequency applications.

In the units with suffix "A" (5¼ and 7" panel height) constant current is provided as a standard feature. The units provide automatic cross-over from constant voltage to constant current operation. The supply will slide into the constant current mode, when the current adjust on the units is programmed for less current than desired by the load resistance. For example, if the current adjust is set to 1A, the voltage adjust set to 36V and the load resistance varied between 0 and 36 ohms, the supply will maintain a constant current output of 1A. When the load resistance exceeds 36 ohms, the current output will drop below 1A and the unit will slide into the constant voltage mode. Consequently when the load resistance, in the above example, varies between 36 ohms and infinity (open circuit) the unit will be in the constant voltage mode. In the constant current mode the open circuit voltage is adjustable over the output voltage of the unit in a similar manner as the output current is limited in the constant voltage mode.

In the constant current mode, if the compliance voltage is required to drop suddenly by more than approximately 5 volts due to an instantaneous reduction in the supply load, the output voltage and current will drop to zero for less than 5 seconds before resuming the normal operating mode.

CONSTANT CURRENT OPERATION (Cont'd)

If the compliance voltage change is less than approximately 5 volts, or in the upward direction, or the voltage change is slow, the supply will maintain the constant current mode without the intermediate drop-out condition.

8) THERMAL OVERLOAD PROTECTION

A thermal sensing element is situated on the heat sink to disconnect the series regulator in case of thermal overload. If the ambient temperature goes beyond the rated ambient operation of the supply for any extended period of time, or if the cooling fan should fail, the thermal switch will open to prevent damage to the unit. After the unit has cooled down, the circuit will re-set itself automatically.

9) OVERVOLTAGE PROTECTION (OV) (OPTIONAL)

The overvoltage protection circuitry automatically keeps the output voltage from rising above the front panel setting even if there is an internal fault condition in the power supply.
If the condition that could cause an overvoltage is a non-fault, temporary condition, the unit will shut itself off. It can be reset by turning the unit "off" and then "on" again.

If the condition causing an overvoltage is an internal component failure, the unit will turn "off" and it will not be possible to turn it "on" again until the internal fault is repaired.
NOTE: In (OV) supplies, a rapid change in output voltage at low loads will tend to simulate a transient condition, and the supply

OVERVOLTAGE PROTECTION (OV) (OPTIONAL) (Cont'd)

will shut off. In this case it is only necessary to reset the supply with the "on-off" switch.

THEORY OF OPERATION

The supply consists of the following sections:

1) Transformer and rectifiers.
2) SCR Preregulator (supplies with suffix "A" only).
3) Series pass section.
4) Error amplifier.
5) Voltage reference.
6) Constant current circuit.

1) Transformer and Rectifiers

The transformer and rectifiers provide full-wave rectified pulsating D.C. voltage of the proper amplitude to the pre-regulator.

2) SCR Preregulator (Supplies with suffix "A" only)

The SCR preregulator maintains the input D. C. voltage approximately 12 volts higher than the output D. C. voltage under all conditions of line and load. This contributes to the low internal loss of the supply, even at low output voltages and high currents. The SCR prereguiator has a response time equal to one-half cycle of line frequency.

3) Series Pass Section

The series pass section is driven from the error amplifier to maintain a constant output voltage. The series pass design is a unique Trygon circuit which dissipates the majority of the

Series Pass Section (Cont'd)

power in the power resistors in parallel with the pass circuit. The power transistors merely add or subtract voltage drops as needed.

4) Error Amplifier

The error amplifier compares the attenuated output voltage with the reference voltage and amplifies the difference. This amplified signal is of the proper phase so as to drive the series pass section in a manner which causes the attenuated output voltage to equal the reference voltage, thus affecting voltage regulation action. The output voltage is varied by changing the attenuation ratio.

5) Voltage Reference

The voltage reference is a highly stable, well regulated, nominal 15 volt internal power supply which acts as a reference for all modes of operation. A highly stable, temperature compensated Zener diode is employed to stabilize the reference.

6) Constant Current Circuit

The constant current operation is obtained by maintaining a constant voltage across an internal current sensing resistor.

CURRENT PROGRAMMING

Remote current programming:

1. Remove link on rear terminals 9 and 10.
2. Then place link between terminals 8 and 9.
3. Connect remote programming resistor between terminals 9 and 10.
4. For a particular current I the approximate program resistor Rpgm is as follows:

$$Rpgm = 100\ (1 - I/I\ max)$$

where I max is the maximum rating of the supply. As an example for a 25 ampere supply if 12.5 amperes were required:

$$Rpgm = 100 \left(1 - \frac{12.5}{25}\right) = 50 \text{ ohms}$$

5. Please note that if the remote program terminals were to open, the output current would be zero. If the remote programming terminals were to be shorted, the unit would go into the voltage mode.
   Approximately 10 milliamperes flows through the remote current resistor and the current stability is directly related to this resistor. Trygon recommends a low temperature coefficient 20 part per million or better be employed.

5-1/4" MERCURY INSTRUMENT SUPPLY

MAINTENANCE SECTION

1- Voltage measurements should be made with a 20,000 ohm per volt voltmeter or a vacuum tube voltmeter. Voltages indicated on the schematic are nominal and may vary plus or minus five (5%) per cent.

2- Transistors should be tested on a Transistor Tester whenever possible. If a tester is not available, an ohmmeter may be used. Diodes and rectifiers may be tested with an ohmmeter.

3- The voltage adjust switches should be in the maximum voltage position and both the current adjust and VERNIER controls should be fully clockwise unless otherwise specified.

4- Jumper terminal 1 with terminal 2, terminal 3 with terminal 4 and jumper terminal 6 with terminal 7, terminal 9 with terminal 10, on the rear barrier strip, TB 1.

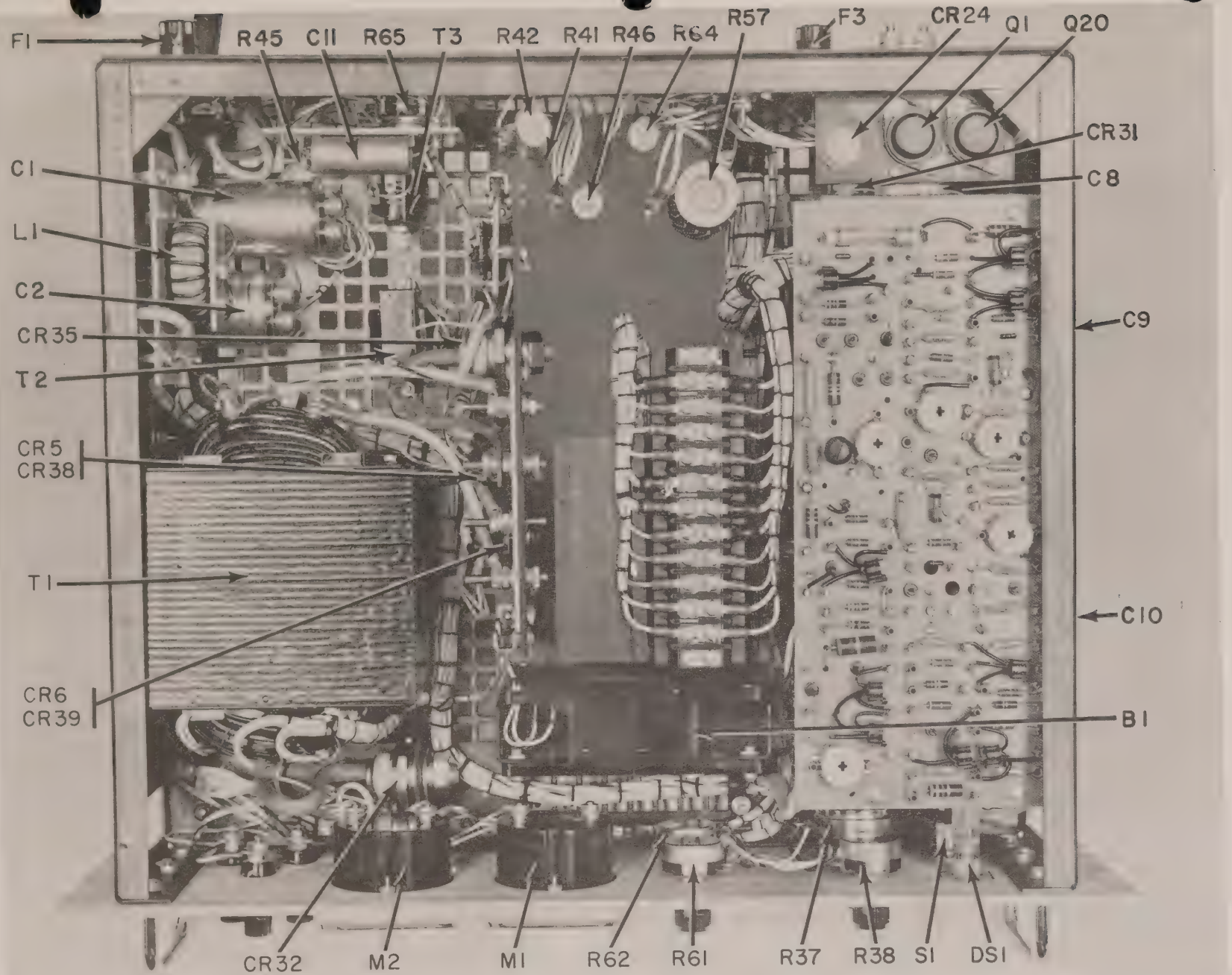
5- Under any failure condition, ascertain that the fuses, F_1 and F_2, are good and that all Zener diodes, CR9 and CR10, have the voltages as indicated on the schematic. It is also advisable to inspect the unit for obvious faults, such as, loose plug-in transistors, faulty grounds, broken wires, broken solder joints and foreign matter that may cause a short.

The following page shows a tabulation of malfunctions and a list of possible components whose failure could cause the problem. The component failure is further divided into open and short circuit conditions to simplify the servicing procedure.

5-1/4" MERCURY INSTRUMENT SUPPLY

"TROUBLE SHOOTING" CHART

Malfuntion	Open Components	Shorted Components
No output voltage	Switches: S2 (Thermal cut-out) Fuses: F1, F2 Transformer: T1, T3 Transistors: Q5, Q6, Q7, Q11, Q12, Q13, Q29 Rectifiers: CR17, CR35 Choke: L1 Resistors: R40, R46, R61, R62, R74	Transistors: Q4, Q8, Q10, Q22 Rectifiers: CR3, CR4, CR5, CR6, CR7, CR8, CR9, CR10, CR14, CR15, CR16, CR20, CR21, CR35, CR38, CR39, CR24 Capacitors: C1, C4, C7, C8, C9, C10
Excessive output voltage	Transistors: Q4, Q14 Rectifiers: CR9, CR10 Resistors: R36, R37, R38	Transistors: Q1, Q2, Q5, Q12, Q13, Q17, Q18, Q19, Q20, Q21
Poor load regulation (voltage)	Rectifiers: CR1, CR2, CR29 Resistors: R45, R54, R55, R65, R90, R91	Rectifiers: CR22, CR23, CR28, CR25, CR30
Poor line regulation (voltage)	Rectifiers: CR7, CR8	
Excessive ripple	Rectifiers: CR4, CR5, CR6, CR38, CR39 Capacitors: C8, C9, C10	
Poor current regulation	Rectifiers: CR19 Resistors: R76, R100	Transistors: Q11, Q29 Rectifiers: CR18



5¼" MERCURY INSTRUMENT SUPPLY

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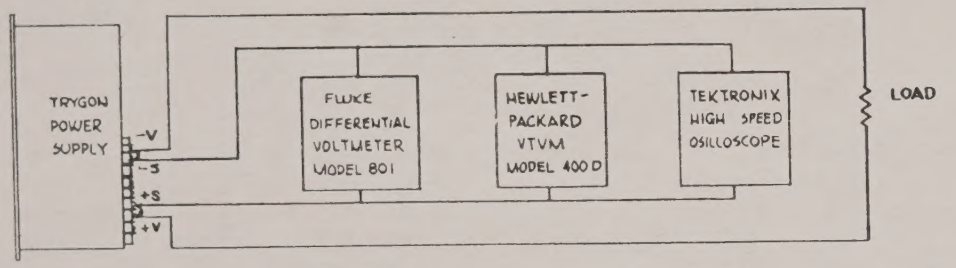
RECOMMENDED TEST SET-UP FOR THE MEASUREMENT OF REGULATION, RIPPLE AND NOISE ON TRYGON POWER SUPPLIES.



NOTES:
1. JUMPERS SHOULD BE INSERTED BETWEEN +S & +V, -S & -V. SECURE JUMPERS PROPERLY
2. CONNECT LOAD BETWEEN +V & -V
3. CONNECT INSTRUMENTS BETWEEN +S & -S

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TEST SET-UP	SIZE B	DRAWING NUMBER 1567 REV

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